SUPPORT FOR THE AMENDMENTS

This Amendment cancels Claim 5; and amends Claims 1, 7, 10-11. Support for the amendments is found in the specification and claims as originally filed. In particular, support for Claim 1 is found in canceled Claim 5. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1-2 and 7-15 will be pending in this application. Claim 1 is independent. Claim 15 is withdrawn from consideration pursuant to a Restriction Requirement.

REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

The present invention provides a titanium alloy material with improved hydrogen adsorption resistance that can be used without risk of hydrogen embrittlement fracture in environments where hydrogen can be easily absorbed. Specification at title; page 1, lines 5-10; page 4, lines 6-10. The titanium alloy material comprises a Ti-Al alloy, and an oxide film on the Ti-Al alloy. A synergistic effect is obtained between the blocking of hydrogen diffusion by the oxide film and suppression of hydrogen diffusion by the parent alloy so that a highly enhanced hydrogen absorption resistance is obtained. Specification at page 8, lines 13-16. Between the Ti-Al alloy and the oxide film is an Al concentration layer, which has an Al concentration that is 0.3% higher or more than that of the Ti-Al alloy and which provides the titanium alloy material with even better hydrogen absorption resistance properties. Specification at page 5, lines 7-12.

Claims 1-2, 8 and 13-14 are rejected under 35 U.S.C. § 103(a) over EP 1 126 139 A2 ("EP-139") in view of *Corrosion Science* 1999, 2031-2051 ("Yen") and further in view of JP 61276996A ("JP-996").

Claim 2 is rejected under 35 U.S.C. § 103(a) over EP-139 in view of Yen and further in view of JP-996 and JP 04143235A ("JP-235").

Claims 5, 7 and 11 are rejected under 35 U.S.C. § 103(a) over EP-139 in view of Yen and further in view of JP-996 and U.S. Patent No. 4,465,524 ("Dearnaley").

Claim 9 is rejected under 35 U.S.C. § 103(a) over EP-139 in view of Yen and further in view of JP-996 and U.S. Patent No. 6,066,359 ("Yao").

Claims 10 and 12 are rejected under 35 U.S.C. § 103(a) over EP-139 in view of Yen and further in view of JP-996 , Dearnaley and Yao.

Claim 5 is canceled, and incorporated into independent Claim 1.

EP-139 discloses a titanium alloy, which contains 0.5-2.3% by mass Al, for a muffler of a car or a motorbike. EP-139 at abstract; [0001].

Yen discloses that a thermally grown oxide film on commercial pure titanium, containing no Al, retards hydrogen embrittlement. Yen at Title; page 2036, Table 1. Yen also mentions that others have shown that sputtered layers of Al_2O_3 on stainless steel effectively retarded hydrogen embrittlement. Yen at page 2032, second paragraph.

The Final Rejection asserts:

> It would have been obvious to one or ordinary skill in the art at the time of the invention to grow a thin nanometer-scale aluminum oxide on the Ti-Al alloy of EP '139. One would have been motivated to do so for two reasons: (1) Hydrogen permeation in titanium metal is decelerated by the presence of a thermally-grown oxide (Yen, Abstract, Figure 3), and (2) Aluminum oxide has been shown to retard hydrogen embrittlement of stainless steel. Final Rejection at page 5, lines 16-21.

On the contrary, there is no motivation to form the sputtered layers of Al_2O_3 for retarding hydrogen embrittlement disclosed in Yen on EP-139's Ti-Al muffler, because automotive mufflers are not required to have resistance to the permeation of hydrogen.

JP-996 discloses a surface treatment of titanium alloy that forms a crystalline oxide. JP-996 at English-language abstract. However, the crystalline oxide on titanium alloys disclosed in JP-996 consists of TiO_2, which does not comprise Al. JP-996 does not disclose that the crystalline oxide retards the permeation of hydrogen. One or ordinary skill in the art would not modify the oxide of Yen by growing it such that is was crystalline rather than amorphous. JP-996 and the other cited prior art fail to the independent Claim 1 limitation that "the oxide film comprises Al and 50 mass% or more of a crystalline oxide".

Dearnaley discloses that bodies made of titanium alloy, having surfaces liable to wear, can have their wear resistance improved by coating such surfaces with a layer of aluminum which has been bombarded with ions so as to cause the aluminum to migrate into the titanium alloy. Dearnaley at abstract. However, Dearnaley fails to suggest that an Al doped layer on Ti-Al alloy improves hydrogen-absorption resistance. Dearnaley also fails to suggest an Al concentration layer containing more Al than that in a base Ti-Al alloy. In addition, Dearnaley fails to suggest the formation of an Al concentration layer between an oxide layer containing Al and a Ti-Al base material. Therefore, one of ordinary skill in the art would not

form the Al concentration layer between the oxide layer of Yen and the Ti-Al alloy of EP-139.

Any *prima facie* case of obviousness based on the cited prior art is rebutted by the significant improvement in hydrogen absorption resistance that is achieved in accordance with independent Claim 1 with a "titanium alloy material comprising a Ti-Al alloy comprising 0.50 - 3.0 mass% of Al, and a balance of Ti and unavoidable impurities; an oxide film on the Ti-Al alloy; and an Al concentration layer between the Ti-Al alloy and the oxide layer, wherein the oxide film has a thickness of 1.0 - 100 nm; the oxide film comprises Al and 50 mass% or more of a crystalline oxide; the Al concentration layer has an Al concentration in a range of from 0.8-25 mass%; and **the Al concentration of the Al concentration layer is 0.3 mass% or more higher than an Al concentration of the Ti-Al alloy**". This is demonstrated in the specification at Table 3, reproduced below.

Table 3

Sample No.	Chemical Composition (mass%)							Surface oxide film			Al concentration layer		Absorbed hydrogen amount *2	Remarks
	Al	Fe	Mo	Ni	Nb	Mn	Ti	Film thickness (nm)	Crystallinity (%)	Structure *1	Al mass%	Thickness (μm)		
41	0.02	0.07	0.02	0.07	0.02	0.01	bal.	5.0	8.3	R	-	-	×	Comparative Example
42	0.50	0.17	0.08	0.08	0.08	0.03	bal.	0.9	10.2	R	(0.50)	-	△	Example
43	2.98	0.08	0.08	0.06	0.08	0.02	bal.	0.8	25.3	B	(0.51)	-	△	Example
44	2.08	0.09	0.08	0.06	0.08	1.01	bal.	1.2	20.5	B	(2.08)	-	O	Example
45	1.50	0.08	0.08	0.07	0.07	0.02	bal.	13	50.2	B	(1.50)	-	OO	Example
46	0.51	0.08	0.08	0.22	0.07	0.02	bal.	5.4	9.8	R	0.82	0.09	OOO	Example
47	0.51	0.07	0.05	0.15	0.06	0.02	bal.	10	30.2	R	0.81	0.08	OOO	Example
48	0.52	0.07	0.11	0.10	0.06	0.01	bal.	1.5	50.1	R	0.82	0.09	OOO	Example
49	2.85	0.08	0.06	0.13	0.06	0.02	bal.	20.3	50.5	B	5.92	0.09	OOO	Example
50	0.51	0.19	0.08	0.06	0.08	0.02	bal.	11	10.7	R	1.31	0.10	OOOO	Example
51	0.52	0.10	0.08	0.15	0.08	0.02	bal.	50.6	10.5	R	1.22	0.11	OOOO	Example
52	1.56	0.11	0.11	0.10	0.06	0.01	bal.	12	9.9	B	2.97	0.10	OOOO	Example
53	2.98	0.08	0.06	0.13	0.06	0.02	bal.	20.3	11.2	B	5.92	0.12	OOOO	Example
54	2.98	0.08	0.06	0.13	0.06	0.02	bal.	10	20.6	B	3.45	29.9	OOOO	Example
55	0.50	0.18	0.08	0.15	0.07	0.02	bal.	95	50.3	R	1.39	0.23	OOOO	Example
56	0.52	0.07	0.08	0.14	0.04	0.01	bal.	30	99.1	R	0.82	1.5	OOOO	Example
57	1.49	0.08	0.09	0.10	0.04	0.01	bal.	1.2	96.5	R	2.33	0.15	OOOO	Example
58	2.81	0.08	0.06	0.13	0.06	0.02	bal.	8.6	75.1	B	4.92	3.3	OOOO	Example
59	2.98	0.08	0.09	0.10	0.04	0.01	bal.	99	95.5	B	3.58	30	OOOO	Example

(NB)
*1 Crystal structure: R: Rutile, A: Anatase, B: Brookite
*2 Hydrogen absorption amount
OOOO: less than 10ppm, OOO: 10-49pppm, OO: 50-99ppm,
O: 100-499ppm, △: 500-999ppm, ×: 1000ppm or more

Table 3 shows that in Sample Nos. 46-59 (with Al concentration layers where the Al concentration of the Al concentration layer was 0.3 mass% or more higher than an Al concentration of the underlying Ti-Al alloy) the absorbed hydrogen amount was significantly reduced relative to that in Sample Nos. 42-45 (with Al concentration layers where the Al concentration of the Al concentration layer was equal to or less than an Al concentration of the underlying Ti-Al alloy).

Dearnaley discloses that implanting titanium with Al improves wear resistance. However, the cited prior art fails to suggest the significant improvement in hydrogen absorption resistance that is achieved in accordance with independent Claim 1 when "the Al concentration of the Al concentration layer is 0.3 mass% or more higher than an Al concentration of the Ti-Al alloy".

Thus, any *prima facie* case of obviousness based on the cited prior art is rebutted.

Because the cited prior art fails to suggest all the limitations of independent Claim 1, there is no motivation to combine Yen with EP-136, and any *prima facie* case of obviousness based on the cited prior art is rebutted, the rejections under 35 U.S.C. § 103(a) should be withdrawn.

Pursuant to MPEP § 821.04, after independent product Claim 1 is allowed, Applicants respectfully request examination and allowance of method Claim 15, which includes all of the limitations of product Claim 1.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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